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THE EXCRETORY SYSTEM IN DIGenea. I.

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NOTES ON THE EXCRETORY SYSTEM OF AN AMPHISTOME, *Cercaria convoluta*, NOV. SPEC.¹

Recently the excretory system of certain distomes has been described. Sewall Wright (1912: 167-170) made a thorough study of the system in the adult *Microphallus opacus*. Cort (1918, 1918a) and the writer (1918, 1918a) have added to the knowledge of these organs in cercariæ and distomula. However, no significant work on the excretory organs of amphistomes has been published since the important monograph of Looss (1892) on *Diplodiscus subclavatus* (Rudolphi). During the past year the writer has been enabled to make a detailed study of the cercaria and parthenita of an undescribed amphistome for which the name *Cercaria convoluta* is proposed. Although the main purpose of this paper is to elucidate the excretory system of this amphistomulum, a brief description of the other organs is made as a matter of record.

Cercaria convoluta nov. spec.

Host: *Planorbis trivolvis* Say.

Parthenita: redia.

Habitat: Urbana, Illinois.

Date: April to November, 1918.

Systematic position: Diplodiscinae.

Cercaria convoluta is a pyriform larva, measuring from 0.4 to 0.76 mm. in length by 0.3 to 0.56 mm. in width. The tail is approximately twice as long as the body. The oral cavity has a maximum outer diameter of 0.1 mm. The acetabulum, situated at the posterior margin of the body, has a width diameter of 0.16 mm. and a length diameter of 0.12 mm. It is directed ventrad. The pharyngeal pockets are large and conspicuous.

¹ Contributions from the Zoölogical Laboratory of the University of Illinois, No. 130.

The esophagus is short; it is surrounded by a small bulbous pharynx just at the point where it opens into the diverticula. The latter extend caudad as far as the excretory pore and are usually undulatory in the adult larva. The genital organs are represented by four cell masses along the median line, suggesting ovary, testes and cirrus sac. Chords of cells run from the generative organs to the genital pore. Two large eye-spots are situated dorsad in the plane where the diverticula originate. They are composed of oval "lenses" surrounded by a mass of melanoidin granules. Dense patches of granules entirely obscure this region. Cystogenous granules form dense aggregates in the connective tissue of the worm. On placing the fluke in water they are freely thrown out and soon dissolve to form a mucus cyst capsule. Meanwhile the tail is easily loosed from the body and cast aside. This species probably belongs to the subfamily Diplodiscinae.

Cercaria convoluta develops within a redia with conspicuous "feet" and a large irregular pouch-like gut. The pharynx at the anterior end of the redia is small. An inconspicuous birth-pore is present. The redia may reach a length of 1.5 to 2 mm.

While the above description suffices to separate *Cercaria convoluta* from previously described cercariae, this species is most strikingly delimited by the convolutions of the main excretory tubules of the cercaria. The excretory pore is located just in front of the anterior margin of the acetabulum. It is surrounded by a strong sphincter, and opens into a small bladder. From the latter organ a single median longitudinal canal runs caudad for about two-thirds the length of the tail. It then bifurcates, each fork opening to the exterior in the distal fifth of the tail. Immediately in front of the bladder is a horizontal collecting tubule which receives the excretory products from right and left sides. As this tubule reaches the sides of the acetabulum it is directed forward. In the very young cercaria it has a serpentine course. This tendency becomes progressively more pronounced as the larva develops, until in the mature cercaria it consists of a spiral of about six definite loops. At the place where the lateral collecting tubule reaches the eye-spot it reflexes outward and backward. Its course may be traced to the region of the bladder where it runs into the acetabulum. The posterior limit of the

main collecting tubule of each side is marked by a bifurcation. The outer (posterior) fork remains free, but the inner (anterior) one joins its mate of the opposite side and thus secures a physiologically important connection between the excretory courses of the two sides of the body.

The flame cells have been carefully studied in living flukes. In the mature cercaria they are naturally divided into three

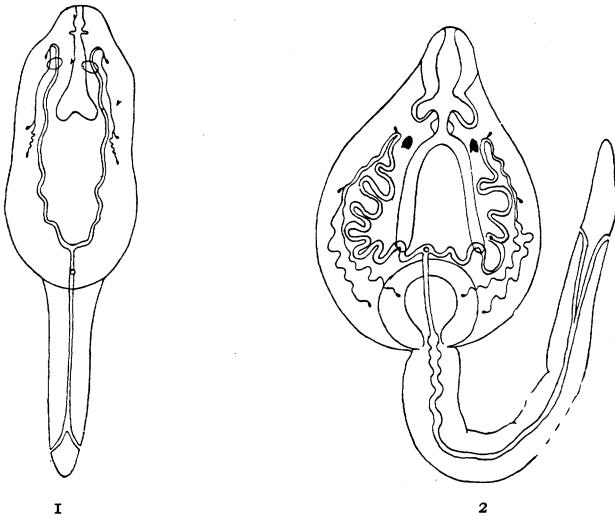


FIG. 1. Very young *Cercaria convoluta*, showing three flame cells on each side of the body. $\times 250$.

FIG. 2. Four cell stage in development of excretory system of *C. convoluta*. $\times 225$.

groups. At the anterior end, given off just after the collecting tubule flexes caudad, there is a cluster of eight cells on each side of the body. Midway down on the reflexed portion of the tubule a single large flame cell is found. In the acetabulum the outer (posterior) tubule of the posteriormost group terminates in a cluster of eight cells. The inner (anterior) likewise gives rise to a cluster of eight terminal flame cells. Analysis shows that the cephalic group of eight cells and the two octet groups in the acetabulum all have an orderly arrangement and are the result of a regular development. Each consists of a quadruple bifurcation of an originally single flame cell. Moreover, this analysis is borne out by the successive stages in the development of the system. The collecting system is originally composed

of a single pair of tubules. Fusion of these two canals occurs at an early stage in the region of the bladder and anterior part of the tail. When the pigmentation of the eye-spots first becomes conspicuous three groups of flame cells are already present, each group being represented by a single cell (Fig. 1). Later, when the animal assumes a more characteristic shape (Fig. 2), the posteriormost cell and tip of the tubule has bifurcated. With the maturing of the cercaria successive stages of division of the anteriormost flame cell into two, four and eight cells may be found. The middle cell remains single, which fact accounts for

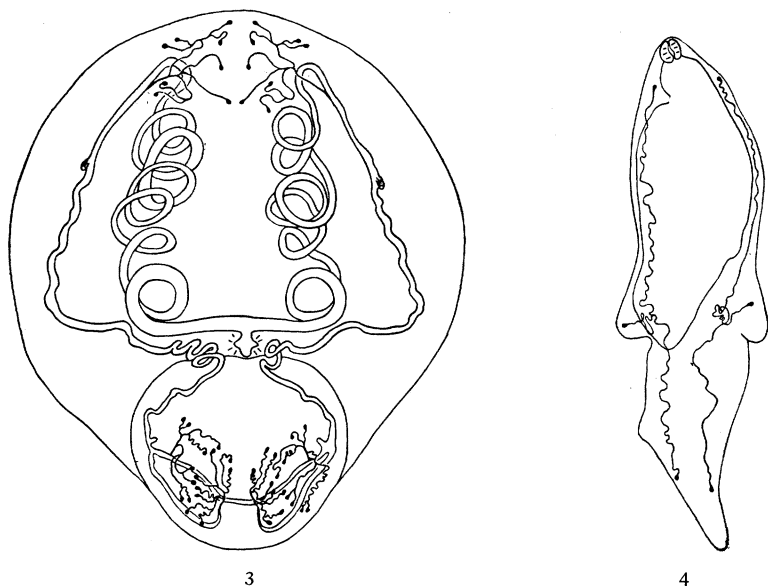


FIG. 3. Mature *Cercaria convoluta*, with 25 flame cells on each side of the body. $\times 175$.

FIG. 4. Excretory system in the parthenita of *C. convoluta*. $\times 175$.

its disproportionately large size. In the posteriormost group the main canal of the inner (anterior) tubule approaches its mate of the opposite side and fuses with it. The cell becomes oriented laterally and gives rise to eight cells. In like manner the outer (posterior) tubule produces eight flame cells near its median margin. Thus there are formed (Fig. 3) twenty-five flame cells on each side of the body of the mature *Cercaria convoluta* from three original groups of one flame cell each.

Proof of the fundamental character of the groups and numbers of flame cells in *Cercaria convoluta* is further established by the analysis of the excretory system of the redia. Here (Fig. 4) there are three groups of flame cells on each side of the body, although the more primitive character of the redia is evidenced by the single cell as representative of each group.

DISCUSSION.

The exact knowledge of the groups of flame cells and exact grouping of these cells in *Cercaria convoluta* makes it possible to understand the importance of the excretory system both in the anatomy and systematology of the group. In his study of *Diplodiscus subclavatus* Looss has shown that the miracidium of his species has a single pair of flame cells at the anterior end of the unbranched collecting tubules. With the metamorphosis into a sporocyst the collecting tubules elongate but the single flame cell on each side persists. In the redia of this species Looss has found from two to four flame cells on each side of the

TABLE I.

SHOWING NUMBER OF FLAME CELLS RESPECTIVELY IN *CERCARIA CONVOLUTA* AND *C. DIPLODISCI SUBCLAVATI* AT VARIOUS STAGES IN THE LIFE HISTORY.

	Mira- cidium- cyst.	Sporo- cyst.	Redia.	Cercaria.				Mature Worm.
				Stage 1.	Stage 2.	Stage 3.	Stage 4.	
<i>C. convoluta</i> . .	?	?	3	1	1 + 1 + 1	1 + 1 + 1 + 1	8 + 1 + 8 + 8	?
<i>C. diplodisci</i> <i>subclavati</i> . . .	1	1	4 (?)	1	1 + 1 + 1 + 1	omitted	3 + 2 + 2 + 8 (9)	?

median line, although he is not sure if the number is constant. In the writer's species there are always three flame cells on each side of the redia. In the cercaria germ-ball in both *C. diplodisci subclavati* and *C. convoluta* there is at first a single flame cell for each lateral collecting tubule. The next stage recognized by Looss in his species is one with four flame cells, each of which appears to represent a separate group. A subsequent stage in Looss's figures shows three cells for the cephalic group, two each for the two groups in the middle of the body and eight (or nine) for the acetabular group. This same number persists in the

mature cercaria. In *Cercaria convoluta*, on the other hand, a distinct three-cell stage is passed through. The four-cell stage is found only after the acetabular cell has divided. Then by successive divisions eight cells are formed from the cephalic and each of the acetabular groups, while the cell in the mid region of the body fails to divide. Thus in the mature cercaria of *Diplodiscus subclavatus* there are fifteen or sixteen flame cells on each side of the body while in the writer's species twenty five flame cells have been consistently found.

In spite of the less pronounced symmetry of division of flame cells in *Cercaria diplodisci subclavati* it is nevertheless highly probable that the grouping is of a fourfold character both in redia and cercaria, just as the arrangement in *C. convoluta* is threefold. Thus within a relatively small subfamily there exists a fundamental difference of arrangement of a relatively conservative system.

SUMMARY.

1. *Cercaria convoluta*, a new species belonging to the Diplo-discinæ, is described.

2. The development of flame cells in both redia and cercaria of this species is based on a three-fold division of a primitively single flame cell on each side of the body.

3. A study of the development of flame cells in *C. diplodisci subclavati*, based on Looss's study, shows a four-fold group arrangement but with less exact symmetry.

4. A comparison of these two forms shows a fundamental difference of arrangement of a relatively conservative system within the same subfamily.

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